International Journal of Environmental, Sustainability, and Social Sciences
ISSN 2720-9644 (print); ISSN 2721-0871 (online)
https://journalkeberlanjutan.com/index.php/ijesss

Liquid Smoke Of Red Fruit (*Pandanus Conoideus.* L.) Waste With Pyrolysis Method For Controlling Sweet Potatoes (*Ipomea Batatas.* L.) Pest

Volume: 3
Number: 1
Page: xxx - xxx

Fransisca Christiana Dewi[1]♥, Sumiyati Tuhuteru[1], Andi Aladin[2], Setiyawati Yani[2], Rohimah Handayani Sri Lestari[3], And Irwan Suluk Padang[4], Bhaskara Anggarda Gathot Subrata[5,6]
[1]Petra Baliem Wamena College of Agricultural Scienceso Agricultural Science, Wamena, Indonesia
[2]Departement of Chemical Engineering, Muslim University of Indonesia (UMI), Makassar, Indonesia
[3]Assesment Institute of Agricultural Technology (AIAT) of Papua, Jayapura, Indonesia
[4]Assesment Institute of Agricultural Technology (AIAT) of Central Sulawesi. Palu, Indonesia
[5]Department of Field Crops, Ondokuz Mayis University, Samsun, Turkey
[6] Department of Agronomy, Amal Ilmiah University, Wamena, Indonesia
Corresponding author: Fransisca Christiana Dewi
E-mail: franciesca.christ11@gmail.com

Article History:
Received: 2021-10-25
Revised: 2021-11-15
Accepted: 2021-11-18

Abstract:

Pandanus conoidus, or red fruit, is a nutrient-dense native Papuan plant, whereas *Ipomea batatas* are the main food for the Wamena people. Biomass from red fruit seed waste can be used as liquid smoke to control *Ipomea batatas* . At a temperature of between 300 - 450 °C, liquid smoke is produced through pyrolysis. Pyrolysis produces phenolic chemicals and aldehydes with antioxidant and antimicrobial properties (anti-bacterial and anti-fungal). The assessment of pH, acidity, and phenol concentration characterizes the quality of liquid smoke. The potential of red fruit seed waste as a liquid smoke product for biopesticides in *Ipomea batatas* is explored in this study.

Additionally, study development aims to determine the optimal method for pyrolyzing red fruit seed waste, its characteristics, chemical content, and the way to use liquid smoke as a biopesticide in *Ipomea batatas*. The results showed that the liquid smoke of grade 3 red fruit seed waste contains 7 components that can be detected using a mass spectrometer. The higher the concentration of liquid smoke produced by grade 3 red fruit seeds, the higher the possibility of *Cylas Formicarius* mortality. *Cylas Formicarius* had the highest mortality rate (90%) when tested at a 7% test solution concentration.

Keywords: Biopesticide, liquid smoke, organic, pandanus, pyrolysis.

Cite this as: Cite This as: First AUTHOR[1], Second AUTHOR[2], Third AUTHOR[3] (YY).“Title Article.” International Journal of Environmental, Sustainability, and Social Sciences, 3 (1), xxx-xxx.

INTRODUCTION

The agricultural and plantation sectors contribute the greatest quantity of biomass waste. Indonesia is an agrarian country endowed with natural resources; as a result, it produces much waste. Biomass can be characterized in various ways, including organic materials, plant remains, and life processes. Forest residues, agricultural residues, industrial wastes, and energy crops all compose biomass. Increased agricultural production affects agricultural waste.

Regrettably, the potential for agricultural biomass utilization has not been fully realized. Several studies have reported that one of the most successful ways to recycle agricultural waste is reused in the agricultural sector by converting biomass waste into liquid smoke that can be used as a biopesticide.

Microbial pesticides and biochemical pesticides are two forms of biopesticides. The biomass waste utilization to produce liquid smoke is included in the category of Biochemical Pesticides, further classified into biopesticides plant-based extracts used as synthetic pesticides for insect pest management (Kumar et al. 2021). Natural raw materials obtained from agricultural biomass waste are used in the manufacturing process; these materials are non-toxic to plants and do not contaminate the environment. Biopesticides are extremely beneficial for future agricultural development that is focused on organic farming. A case study in the Wamena area of Jayawijaya Regency, Papua, where local government policy restricts chemicals in agricultural cultivation operations, biopesticides serve as an effective pest control alternative.

Biomass waste utilized as a biopesticide is a specific study in this research, and red fruit seed waste is a unique study in this research. The waste of red fruit seeds is produced from the agricultural products of red fruit, a unique and endemic Papuan fruit. The pyrolysis method can process biomass raw materials such as red fruit seed waste (Pandananus conoideus. L), which is abundant in Wamena (Papua). The liquid smoke is then utilized as a biopesticide to eradicate insect pests on sweet potato plants (*Ipomea batatas* . L), the main food in Wamena. This study aims to investigate the potential for liquid smoke development of *Pandanus conoideus*. L in Wamena, Jayawijaya Regency, Papua as a biopesticide for agricultural concerns and controlling insect pests in sweet potato (*Ipomea batatas* . L).

METHODS

Material

A pyrolysis reactor, analytical balance, Erlenmeyer 125 mL, petri dish, oven, desiccator, spray bottle, sample bottle, and maintenance container were all used in this study. In addition, this study made use of red fruit seed debris, a paper filter, and distillates water.

Instrumentation

GC-MS instrumentation was used in 2010. This instrument is utilized in the analysis of volatile organic chemical compounds. Volatile compound samples were injected into the GC system,

and the separation process was performed in the column based on the nature of the polarity. After eluting from the GC system, each compound isolated will be fragmented with specific ionization energy in the MS system.

General Instructions

Procedure Pyrolisis

The technique for producing liquid smoke has been described in previous studies (Faisal et al. 2014; Faisal et al. 2016; Aladin et al. 2017; Aladin et al. 2018; Indriati et al. 2018; Sari et al. 2018). First, the red fruit biomass waste material used is cleaned from the existing dirt mixture in preparation. Furthermore, the materials are classified according to their size (3 levels of size), including homogeneity of the material's moisture level and drying to lower the moisture content (dry basis).

After a particular amount of material has been prepared, it is delivered into the pyrolysis reactor, where combustion commences. The reactor's pyrolysis reaction operates between 300 and 450 ºC and takes 2- 3 hours to complete (figure 1). The smoke produced by combustion is condensed in a circular coil immersed in a cooling water bath through a condenser. The grade 3 liquid smoke was then tested on sweet potato plants as a biopesticide.

Observations were repeated for variations in the mass of the material with the composition of the material in the reactor chamber (500 g and 1 kg), variations in pyrolysis combustion time (2 and 3 hours), variations in combustion temperature (300 - 450ºC).

More Instructions

Figure 1. Reaktor Pyrolyis for experiments

The sample is generally placed into the reactor for pyrolysis tests. After that, the reactor is tightly sealed to ensure that no smoke escapes during the heating process. Temperatures used to range between 300 - 450 ºC. The smoke generated during combustion is then condensed in the condensing unit, where it instantly transforms into a liquid. Grade 3 liquid smoke is obtained immediately following the smoke melts. GC-MS was used to analyze the chemical content of the liquid smoke (Wagania et al., 2018). Additionally, the efficacy of liquid smoke to act as a biopesticide was evaluated using insects that attack sweet potato plants (Kim et al., 2012; Gani et al. 2014; Soedijo et al. 2015; Risfaheri et al. 2018; Wagania et al. 2018). Liquid

smoke concentrations were changed between 1% - 7%. The percentage of insects that died at each concentration of liquid smoke was the controlling variable. Pyrolysis liquid smoke was prepared in four concentrations of 1%, 3%, 5%, and 7%, then placed in a spray bottle. 25 *Cylas Formicarius* were prepared for ± 5 hours without food to assess whether they died due to the components in liquid smoke. After ± 5 hours, up to five *Cylas Formicarius* were placed in a clean plastic container and fed sweet potato leaves that had been sprayed twice with four different concentrations. There was also control that used solely distilled water as a spray. Within 24 hours, three times, observations are made. The following equation is used to get the mortality rate as a percentage:

$$\%Mortalitas = \frac{C1 - C2}{C1} X\ 100\% \quad \textbf{(1)}$$

C1 and C2 represent the numbers of *Cylas Formicarius* that were alive before and after testing.

RESULT AND DISCUSSION

Table 1. Mass Spectrum of Grade 3 Red Fruit Seed Waste Liquid Smoke

Peak	tR (minute)	Compound content %	Name of Compounds
1	2.024	30.41	Oxalic Acid Methyl Esters
2	2.143	0.31	Butanedione
3	2.532	47.85	Acetic Acid
4	2.899	7.55	1-Hydroxy-2-Propanone
5	5.465	4.21	Propanoic Acid
6	6.593	4.89	Furan Carboxaldehyde
7	8.771	3.24	Phenol

Source: Data Processed

The study by liquid smoke gas chromatography of waste biomass of red fruit seeds based on pyrolysis results produced 7 peaks. It is composed of phenol, carboxylic acid, furan, lactone, and alcohol. These compounds decompose cellulose, hemicellulose, lignin, and other wood components (Wagiman et al., 2014; Faisal et al., 2016). Based on GC chromatogram analysis, the pyrolysis results of grade 3 liquid smoke in red fruit seed waste contained 7 peaks of the compound spectrum. The spectrum results of these compounds were oxalic acid methyl esters, butanedione, acetic acid, 1-hydroxy-2-propanone, propanoic acid, furan carboxaldehyde, and phenol (Table 1). Liquid smoke contains organic compounds that have been oxidized, such as aldehydes, carboxylic groups, ketone acids, and, most commonly, phenols. The compound is produced by steam condensation from pyrolysis plants (non-oxygen combustion) and wood processing at 400 °C (Dediwanto et al. 2020). The 7 compounds in the liquid smoke content of grade 3 red fruit seed waste act as a supplementary antifeedant, reducing *Cylas Formicarius*

appetite Antifeedant bioactive compounds could be another crop protection strategy (Isa et al. 2019). This substance does not kill, repel (Kendra et al. 2014; Faisal et al. 2016; Oramahi et al. 2018), or entangle insect pests; it just prevents them from feeding (anti-food). An antifeedant compound is a substance that, depending on its potency, can temporarily or permanently suppress eating (Baskar and Ignacimuthu 2012; Alpian et al. 2014). Several studies on antifeedant bioactive compounds found that the isolated crude extract of Gliricidia sepium acted as an antifeedant against various insects (Alpian et al. 2014; Aladin et al. 2018).

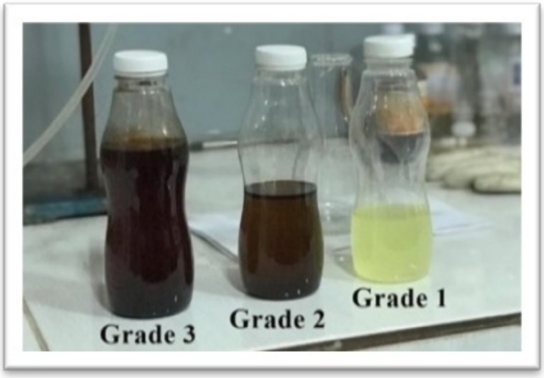

Figure 2. Pyrolysis Liquid Smoke pandanus conoideus

Cylas Formicarius mortality test on liquid smoke of grade 3 red fruit seed waste showed an average mortality rate of 20% in controls, 40%, 50%, 70%, and 90% at concentrations of 1%, 3%, 5%, and 7% respectively. In addition, the results show that lower concentrations result in lower toxicity scores for the mortality test, whereas higher concentrations result in higher toxicity scores.

Figure 3. *Cylas Formicarius* Mortality Test

The impact of the deaths that occurred is thought to be because the compounds in liquid smoke function as anti-food and poisons. The mechanism of action is that liquid smoke sprayed on sweet potato leaves first enters the body of *Cylas Formicarius*, which has been eaten for 24

hours. *Cylas Formicarius* dies due to toxins entering the eaten sweet potato leaves. Then in the cells of the body of *Cylas Formicarius* , there is damage to cell metabolism, which inhibits the transport of electrons in the mitochondria so that the formation of energy from food in the cells does not occur, which causes *Cylas Formicarius* to die by itself.

Table 2. The pH Content of The Red Fruit Waste Liquid Smoke

No	Concentration Treatment of Liquid Smoke	pH Liquid Smoke (mg/mL)	Mortality of *Cylas Formicarius* (%)
1	1	3.42	40 a
2	3	5.18	50 b
3	5	7.21	70 c
4	7	12.44	90 d

Note: Means in columns followed by the same letter are not significantly different according to the LSD test ($P < 0.05$).

Source: Data Processed 2021

Using universal indicators, the acidity level of the liquid smoke of red fruit seed waste was determined. The tests show that the level of liquid smoke increases as the concentration of the liquid smoke solution increases. The results meet the Japanese specification liquid smoke quality standards because the pH value range of 1.50-3.70 is met in this study (Li et al., 2015). The acid content of grade 3 liquid smoke varies depending on the test solution type. The higher the concentration, the more acidic the solution (Table 2).

This pH value represents the acidity of the liquid smoke produced by the red fruit seed waste. With increasing temperature and combustion time, the pH value decreases. It is due to an increase in red fruit seed waste components that decompose to generate acidic chemical compounds. The low pH value obtained will limit microbial growth (Rumbaina Mustikawati et al. 2016).

Because there is limited information about the content of red fruit seeds, there are not many sources to back it up. According to the analysis, the acetic acid content in the liquid smoke of red fruit waste is quite high, reaching 47.85 %, as acetic acid is the main liquid smoke content produced by the pyrolysis of cellulose. The solution is produced in two stages: cellulose hydrolysis to glucose, followed by pyrolysis to acids, water, furans, and phenols. It

indicates that red fruit seed waste is thought to have a high cellulose content. When the cellulose hydrolysis event begins, it produces a large amount of glucose, transformed into acids through pyrolysis.

Because it is stable, non-volatile, and inexpensive, the liquid smoke of red fruit seed (*Pandanus conoideus*. L.) can be used as a biopesticide. However, research on the efficacy of liquid smoke as a biopesticide is still in its early stages. To establish a sustainable agricultural industry, more research on liquid smoke and its use in agriculture is required. It can offer economic value, particularly when trash and organic by-products produce liquid smoke (Risfaheri et al., 2018; Wagania et al., 2018). Acetic and carbonyl acids and glucose, acetaldehyde, and acrolein were produced from cellulose pyrolysis. Lignin pyrolysis produces phenols, guaiacol, syringes, and their homologs and derivatives. The number and types of compounds found in liquid smoke during pyrolysis and the raw materials used are heavily influenced by temperature (Sukharnikov et al. 2015; Faisal et al. 2016; Tima, Yopi and Ifa, 2016; Faisal, R.YelviaSunarti and Desvita 2018).

CONCLUSION

From our results, the liquid smoke of grade 3 red fruit seed waste contains 7 components that can be detected using a mass spectrometer: methyl esters of oxalic acid, butanedione, acetic acid, 1-hydroxy-2-propanone, propanoic acid, furan carboxaldehyde, and phenol. The effect of grade 3 liquid smoke on the insect *Cylas Formicarius* increased as the concentration of the test solution increased. The higher the concentration of liquid smoke produced by grade 3 red fruit seeds, the higher the possibility of *Cylas Formicarius* mortality. *Cylas Formicarius* had the highest mortality rate (90%) when tested at a 7% test solution concentration.

REFERENCES

Aladin A, Alwi RS, Syarif T. 2017. Design of pyrolysis reactor for the production of bio-oil and bio-char simultaneously. AIP Conf Proc. 1840(1): 110010. DOI:10.1063/1.4982340.

Aladin A, Yani S, Modding B, Wiyani L. 2018. Pyrolisis Of Corncob Waste To Produce Liquid Smoke. IOP Conf Ser Earth Environ Sci. 175(1): 012020. DOI:10.1088/1755-1315/175/1/012020.

Alpian A, Prayitno TA, Pramana J, Sutapa G, Budiadi B. 2014. Kualitas Asap Cair Batang Gelam (*Melaleuca* sp.). J Penelit Has Hutan. 32(2): 83–92. DOI:10.20886/JPHH.2014.32.2.83-92. [Indonesian]

Baskar K, Ignacimuthu S. 2012. Antifeedant, larvicidal and growth inhibitory effects of ononitol monohydrate isolated from *Cassia tora* L. against *Helicoverpa armigera* (Hub.) and *Spodoptera litura* (Fab.) (L*epidoptera: Noctuidae*). Chemosphere. 88(4): 384–388. DOI:10.1016/J.CHEMOSPHERE.2012.02.051.

Dediwanto Y, Oramahi HA, Nurhaida. 2020. The Potential of Liquid Smoke from Bengkirai Wood in Inhibiting The Growth of Schizophyllum commune In Vitro. J Galung Trop. 9(1): 1–9. DOI:10.31850/jgt.v9i1.518. [Indonesian]

Faisal M, Gani A, Baihaqi A. 2014. Potential Development of Liquid Smoke from Oil Palm Solid Waste as Bio fungicides. Int J Sci Eng. 7(1): 65–69. DOI:10.12777/ijse.7.1.65-69.

Faisal M, Gani A, Husni, Baihaqi A, Daimond H. 2016. Pyrolysis of Oil Palm Kernel Shell into Liquid Smoke and its Application to Control Anthracnose Disease on Chili (*Capsicum annum* L.). J Eng Appl Sci. 11(12): 2583–2587. DOI:10.36478/jeasci.2016.2583.2587.

Faisal M, R.YelviaSunarti A, Desvita H. 2018. Characteristics of liquid smoke from the pyrolysis of durian peel waste at moderate temperatures. Rasayan J Chem. 11(2): 871–876. DOI:10.31788/RJC.2018.1123035.

Gani A, Husni H, Baihaqi A, Faisal M. 2014. Potential Development of Liquid Smoke from Oil Palm Solid Waste as Bio fungicides. Int J Sci Eng. 7(1): 65–69. DOI:10.12777/IJSE.7.1.65-69.

Indriati G, Samsudin S. 2018. Potential of Liquid Smoke as Botanical Insecticide to Control Coffee Berry Borer *Hypothenemus hampei*. J Tanam Ind dan Penyegar. 5(3):123–134. DOI:10.21082/jtidp.v5n3.2018.p123-134. [Indonesian]

Isa I, Musa WJA, Rahman SW. 2019. Pemanfaatan Asap Cair Tempurung Kelapa Sebagai Pestisida Organik Terhadap Mortalitas Ulat Grayak (*Spodoptera Litura* F.). Jamb J Chem.(1): 15–20. [Indonesian]

Kendra PE, Montgomery WS, Niogret J, Schnell EQ, Deyrup MA, Epsky ND. 2014. Evaluation of seven essential oils identifies cubeb oil as most effective attractant for detection of *Xyleborus glabratus*. J Pest Sci 2014 874. 87(4): 681–689. DOI:10.1007/S10340-014-0561-Y.

Kim SP, Kang MY, Park JC, Nam SH, Friedman M. 2012. Rice hull smoke extract inactivates *Salmonella typhimurium* in laboratory media and protects infected mice against mortality. J Food Sci. 77(1): M80–M85. DOI:10.1111/J.1750-3841.2011.02478.X.

Kumar J, Ramlal A, Mallick D, Mishra V. 2021. An overview of some biopesticides and their importance in plant protection for commercial acceptance. Plants. 10(6):1185. DOI:10.3390/PLANTS10061185.

Li H, Chen C, Cao X. 2015. Essential oils-oriented chiral esters as potential pesticides: Asymmetric syntheses, characterization and bio-evaluation. Ind Crops Prod. 76:432–436. DOI:10.1016/J.INDCROP.2015.07.027.

Oramahi HA, Wardoyo ERP, Kustiati K. 2018. Efikasi Asap Cair dari Kayu Bengkirai terhadap Phytophthora citrophthora. J Perlindungan Tanam Indones. 22(2): 160–166. DOI:10.22146/JPTI.33113.

Risfaheri R, Hoerudin H, Syakir M. 2018. Utilization of Rice Husk for Production of Multifunctional Liquid Smoke. J Adv Agric Technol. 5(3): 192–197. DOI:10.18178/joaat.5.3.192-197.

Rumbaina Mustikawati D, Mulyanti N, Wylis Arief R. 2016. Study Effectiveness of Liquid Smoke as a Natural Insecticide for Main Pest Control of Soybean Crops. Int J Sci Basic Appl Res. 30(1): 237–245.

Sari Y, Sari YP, Samharinto S, Langai BF. 2018. Penggunaan asap cair tandan kosong kelapa sawit (tkks) sebagai pestisida nabati untuk mengendalikan hama perusak daun tanaman sawi (*Brassica juncea* L.). EnviroScienteae. 14(3): 272–284. DOI:10.20527/es.v14i3.5699.

Soedijo S, Pramudi MI, Salamiah SA. 2015. Introduction study of potential of natural insecticide liquid smoke from solid waste oil palm to brown planthopper (*Nilaparvata lugens stall*) in south Kalimantan. Asian J Appl Sci. 3(1):2321–0893.

Sukharnikov YI, Esengaraev EK, Turgenbaev AT, Iskakov MS. 2015. Production, properties and use of the rice hulls pyrolysis organic product as a disinfectant. World J Vet Med Eng. 1(1):1–9.

Tima S La, Yopi, Ifa L. 2016. Pemanfaatan asap cair kulit biji mete sebagai pestisida. J Chem Process Eng. 1(2): 16–22. DOI:10.33536/JCPE.V1I2.66. [Indonesian]

Wagania L, Dewe I, Anom K, Kapahang A. 2018. Pyrolisis of Salak Seed (*Salacca zallaca*) and Toxicity Test of Its Liquid Smoke to the Mortality of *Artemia salina*

Leach Larvae. Int J Appl Eng Res. 13 :10593–10597.

Wagiman FX, Ardiansyah A, Witjaksono. 2014. Activity of coconut-shell liquid-smoke as an insecticide on the rice brown planthopper (*Nilaparvata lugens*). ARPN J Agric Biol Sci. 9(9): 293–296.